

Form PTO-1390

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

P21533.P01

P21533

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/926287

INTERNATIONAL APPLICATION NO.

INTERNATIONAL FILING DATE

PRIORITY DATE CLAIMED

PCT/JP00/02303

07 April 2000

08 April 1999

TITLE OF INVENTION

NONAQUEOUS ELECTROLYTE RECHARGEABLE BATTERY

APPLICANT(S) FOR DO/EO/US

Kenji KIMURA, Keisuke OMORI and Seiichi UEMOTO

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3))
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (U.S.C. 371(c)(5)).

Items 11 to 16 below concern other document(s) or information included:

11. Assignee: MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD., of Osaka, JAPAN
12. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
13. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
14. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☒ Figure of Drawing to be published_1_
18. ☒ Other items or information:

International Application as published (in Japanese).
PCT/IB/304.
PCT/IB/308.
PCT/ISA/210.
Claim of Priority.

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/ 926287

INTERNATIONAL APPLICATION NO.

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19. ☒ The following fees are submitted:

CALCULATIONS

PTO USE ONLY

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search report has been prepared by the EPO or JPO. \$ 890.00

International preliminary examination fee paid to USPTO (37 CFR 1.482). \$ 710.00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO(37 CFR 1.445(a)(2)). \$ 740.00

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO. \$1,040.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4). \$ 100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =

\$ 890.00

Surcharge of \$130.00 for furnishing the oath or declaration later than 20 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

\$ 0.00

Claims	Number Filed	Number Extra	RATE	\$	
Total Claims	4 - 20 =	0	X \$18.00	\$ 0.00	
Independent Claims	1 - 3 =	0	X \$84.00	\$ 0.00	
Multiple dependent claim(s) (if applicable)			+ \$280.00	\$ 0.00	

TOTAL OF ABOVE CALCULATIONS =

\$ 890.00

— Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by $\frac{1}{2}$.

\$ 0.00

SUBTOTAL =

890.00

Processing fee of \$130.00 for furnishing the English translation later than 20 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

+

0.00

Extension of Time fee in the amount of \$

0.00

TOTAL NATIONAL FEE =

890.00

Fee for recording the enclosed assignment (37 CFR 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property

+

40.00

TOTAL FEES ENCLOSED =

930.00

Amount to be refunded

\$

Charged

\$

a. ☒ A check in the amount of \$ 930.00 to cover the above fees is enclosed.b. — Please charge my Deposit Account No. — in the amount of \$ — to cover the above fees.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-0089.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO CUSTOMER NO. 7055
AT THE PRESENT ADDRESS OF:Bruce H. Bernstein
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07055

PATENT TRADEMARK OFFICE

SIGNATURE

Bruce H. Bernstein
NAME

29,027

REGISTRATION NUMBER

P21533.A01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Kenji KIMURA et al.

Serial No : Not Yet Assigned (National Stage of PCT/JP00/02303)

Filed : Concurrently Herewith (International Filing Date April 7, 2000)

For : NONAQUEOUS ELECTROLYTE RECHARGEABLE BATTERY

PRELIMINARY AMENDMENTCommissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Prior to calculation of the filing fees and the examination of the above-identified patent application on the merits, the Examiner is respectfully requested to amend the claims as follows:

IN THE CLAIMS

Please amend the claims as follows (a marked-up copy of the claim amendments is provided as an attachment to this Amendment):

1. (Amended-Clean Text) A nonaqueous electrolyte rechargeable battery comprising:
an electrode group including a positive electrode plate including a positive electrode material, a negative electrode plate, the positive and negative electrode plates being superposed and wound with a separator interposed therebetween;

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an electrolyte; and

a battery case for accommodating the electrode group and the electrolyte; wherein:

corona discharge treatment is performed on one of the positive electrode material and the positive electrode plate.

2. (Amended-Clean Text) The nonaqueous electrolyte rechargeable battery according to claim 1, wherein corona discharge treatment is performed on one of the negative electrode material and the negative electrode plate.

3. (Amended-Clean Text) The nonaqueous electrolyte rechargeable battery according to claim 1, wherein corona discharge treatment is performed on the separator.

Please add new claim 4 as follows:

---4. (Amended) The nonaqueous electrolyte rechargeable battery according to claim 2, wherein corona discharge treatment is performed on the separator.---

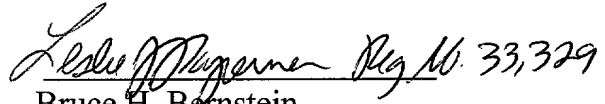
REMARKS

By the above amendment, claims 1-3 have been amended and claim 4 has been added to delete multiple dependency. Also, the reference numbers in the claims have been deleted and claim 1 has been amended to correspond to the published application.

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If there should be any questions, the Examiner is invited to contact the undersigned
at the telephone number listed below.

Respectfully submitted,
Kenji KIMURA et al.


Bruce H. Bernstein
Reg. No. 29,027

October 5, 2001
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MARKED-UP COPY OF AMENDED CLAIMS

1. (Amended) A nonaqueous electrolyte rechargeable battery comprising:

an electrode group including a positive electrode plate [(1, 21)] including a positive electrode material [(1a)], a negative electrode plate [(2, 22)], the positive and negative electrode plates being superposed and wound with a separator [(3, 23)] interposed therebetween;

an electrolyte; and

a battery case [(4, 27)] for accommodating the electrode group and the electrolyte;

wherein:

corona discharge treatment is performed on one of the positive electrode material [(1a)] and the positive electrode plate [(1, 21)].

2. (Amended) The nonaqueous electrolyte rechargeable battery according to claim 1, wherein corona discharge treatment is performed on one of the negative electrode material [(2a)] and the negative electrode plate [(2, 22)].

3. (Amended) The nonaqueous electrolyte rechargeable battery according to claim 1 [one of claims 1 and 2], wherein corona discharge treatment is performed on the separator [(3, 23)].

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410 Rec'd PCT/PTO 09 OCT 2001

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DESCRIPTION

NONAQUEOUS ELECTROLYTE RECHARGEABLE BATTERY

5 TECHNICAL FIELD

The present invention relates to a nonaqueous electrolyte rechargeable battery.

BACKGROUND ART

10 Recent progress in miniaturization and weight reduction of electronic equipment has brought about increasing demands for miniaturization, weight reduction and increased capacity of the batteries which are used as their power sources.

To meet these demands, a nonaqueous electrolyte
15 rechargeable battery of high energy density which employs metallic lithium or lithium alloy as the negative electrode active material has attracted attention. However, batteries which employ metallic lithium or lithium alloy as the
negative electrode active material have problems that hinder
20 them from being put into practical use such as deterioration of the cycle characteristic or internal short-circuiting due to dendritic precipitation of the lithium on the negative electrode produced as charging proceeds.

Accordingly, nonaqueous electrolyte rechargeable
25 batteries employing a carbon-based material as the negative

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electrode active material and a transition metal oxide containing lithium, such as LiCoO_2 , as the positive electrode active material have been put into practice by various companies. Such nonaqueous electrolyte rechargeable batteries have excellent cycle characteristics, since they are free from the problem of precipitation of the lithium on the negative electrode. Development of such nonaqueous electrolyte rechargeable batteries is therefore being vigorously pursued and their incorporation into electronic equipment continues apace.

Development of nonaqueous electrolyte rechargeable batteries is also being pursued in keeping with concern over the global environment or energy problems. A technique for load equalization is desired in order to secure stable power supply while maintaining a good global environment: considerable load equalization would be effected if use of small-scale battery power storage devices capable of storing power during the night could be made common in ordinary households etc. In order to prevent atmospheric pollution caused by car exhaust gases and global warming due to CO_2 , it would also be desirable to extend the use of electric vehicles in which some or all of the motive power is obtained by rechargeable batteries. Large nonaqueous electrolyte rechargeable batteries with a cell capacity of about 100 Ah are therefore being developed for use as battery power

storage devices for domestic use and as power sources for electric vehicles.

However, in the above described nonaqueous electrolyte rechargeable batteries, poor wetting property of the electrolyte towards positive electrode material hinders uniform mobility of lithium ions, resulting in considerable polarization at the positive electrode. The nonaqueous electrolyte rechargeable batteries thus fail to achieve excellent charging/discharging characteristic, and furthermore they require a long time for pouring in the electrolyte due to the poor wetting property of the electrolyte, resulting in poor productivity.

Corona discharge treatment is a well-known technique for improving the wetting property of the separator towards the electrolyte. In addition, Laid-open Japanese Patent Application No. H7-183027 discloses performing corona discharge treatment in order to improve the wetting property of the carbon-based material of the negative electrode plate towards the electrolyte.

In the light of the above problems of the prior art, an object of the present invention is to provide a nonaqueous electrolyte rechargeable battery in which charging/discharging characteristic is improved by improving wetting property of the positive electrode material towards the electrolyte, and the productivity is improved by

shortening the time required for pouring in the electrolyte.

DISCLOSURE OF THE INVENTION

In a nonaqueous electrolyte rechargeable battery
5 according to the invention, in which a positive electrode
plate and a negative electrode plate are superimposed with a
separator between them, and are accommodated in a battery
case together with electrolyte, corona discharge treatment is
performed on the positive electrode material or the positive
10 electrode plate manufactured therefrom. The
charging/discharging characteristic of the battery is
improved since the lithium ions are permitted to easily reach
the surface of the positive electrode material, due to
increased affinity between the positive electrode material of
15 the positive electrode plate and the electrolyte by the
corona discharge treatment. The corona discharge treatment is
more effective in a battery in which the packing density of
the positive electrode material is raised in order to raise
the battery capacity per unit volume, since this would
20 otherwise result in lowering of the wetting property of the
positive electrode material towards the electrolyte.

It should be noted that, as in the prior art described
above, wetting property of the separator or the negative
electrode plate towards the electrolyte is raised by
25 performing corona discharge treatment on the separator or the

negative electrode plate. However, improved charging/discharging characteristic obtained by improving wetting property of the positive electrode plate towards the electrolyte by corona discharge treatment is remarkable since polarization at the positive electrode is much more severe than that at the negative electrode particularly in high-rate charging/discharging. Considerably increased productivity is also achieved by shortening the pouring time by performing corona discharge treatment to improve the wetting property of the positive electrode material towards the electrolyte, since it has smaller particles than the negative electrode material in layer form.

Preferably, corona discharge treatment is also performed on the negative electrode material or the negative electrode plate manufactured therefrom, and on the separator as well. Their improved wetting property towards the electrolyte leads to improved wetting property of the entire electrode plate group, with the result that a further reduction in pouring time of the electrolyte is achieved in the case not only of comparatively small rechargeable batteries of about 600 mAh but also in particular of nonaqueous electrolyte rechargeable batteries of about a few tens to a few hundreds of Ah, since the area of their electrode plates increases as the battery size is made larger. Productivity of batteries is thus raised.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a longitudinal cross-sectional view of a nonaqueous electrolyte rechargeable battery according to an embodiment of the present invention;

5 Figure 2 is a detailed cross-sectional view of a positive electrode plate, a negative electrode plate, and a separator in the battery;

Figure 3 is a diagram schematically illustrating the positive electrode material, the negative electrode material, and the movement of lithium ions during charging/discharging;

Figure 4 is a plan view showing how corona discharge treatment is performed; and

Figure 5 is a longitudinal cross-sectional view of a nonaqueous electrolyte rechargeable battery according to another embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

A nonaqueous electrolyte rechargeable battery according to an embodiment of the present invention will be described with reference to Figure 1 to Figure 4.

In Figure 1, numeral 1 represents a positive electrode plate and numeral 2 represents a negative electrode plate. An electrode group is formed by overlaying them with a separator 3 made of microporous polyethylene film interposed between them, and winding them in a spiral fashion. The electrode

group is accommodated in a battery case 4 together with the electrolyte. The battery case 4 includes a cylindrical battery can 5 constituting a negative electrode terminal and a battery closure 6 constituting a positive electrode terminal. An insulating packing 7 is interposed between the inner circumference of the top aperture of the battery can 5 and the outer circumference of the battery closure 6, whereby mutual insulation is effected therebetween and the battery case 4 is sealed. The separator 3 is interposed also between the electrode group and the inner circumference of the battery can 5.

The positive electrode plate 1 is constituted by coating both surfaces of a positive electrode current collector 1b with a positive electrode material 1a; a side part (in the example illustrated, the top part) of this positive electrode current collector 1b projects from the portion that is coated with the positive electrode material 1a. The negative electrode plate 2 is constituted by coating both surfaces of a negative electrode current collector 2b with a negative electrode material 2a; a side part opposite from the projected portion of the positive electrode current collector 1b (in the example illustrated, the bottom part) of this negative electrode current collector 2b projects from the portion that is coated with the negative electrode material 2a. The separator 3 projects to the outside beyond both side

edges of the coated portions of the positive electrode plate 1 and the negative electrode plate 2. A positive electrode current collecting plate 8 is joined to the positive electrode current collector 1b and a negative electrode current collecting plate 9 is joined to the negative electrode current collector 2b. The positive electrode current collecting plate 8 and the negative electrode current collecting plate 9 are respectively connected to the battery closure 6 and the battery can 5.

A detailed description of the positive electrode plate 1 and the negative electrode plate 2 will now be given with reference to Figure 2. The positive electrode current collector 1b is made of aluminum foil or the like. The positive electrode plate 1 is constituted by coating both surfaces of the positive electrode current collector 1b with a positive electrode material 1a containing a positive electrode active material and a binder. For the positive electrode active material, LiCoO_2 , LiMn_2O_4 , LiNiO_2 , any other lithium oxide in which one of Co, Mn or Ni is substituted with another transition metal, or a lithium-containing transition metal oxide other than these, may be used. In particular, Mn-based lithium-containing transition metal oxides such as the globally abundant low-cost LiMn_2O_4 are suitable.

The negative electrode current collector 2b is made of

copper foil or the like and the negative electrode plate 2 is constituted by coating both surfaces of the negative electrode current collector 2b with a negative electrode material 2a containing a negative electrode active material and a binder. For the negative electrode active material, carbon-based materials such as graphite, petroleum coke, carbon fiber, or organic polymer sintered products, or metals or oxides, or composite materials of these capable of occluding and releasing lithium, may be used.

The electrolyte may be obtained by dissolving a lithium salt such as lithium hexafluorophosphate (LiPF_6), lithium perchlorate (LiClO_4), or lithium fluoroborate (LiBF_4) into a nonaqueous solvent such as ethylene carbonate (EC), propylene carbonate (PC), diethylene carbonate (DEC) or ethylene methyl carbonate (EMC), either alone or in combination, at a concentration of 0.5 mol/dm^3 to 2 mol/dm^3 . A polyolefin-based microporous film may be employed as the separator.

To give a specific example, electrolyzed manganese dioxide (EMD: MnO_2) and lithium carbonate (Li_2CO_3) were mixed at a ratio $\text{Li/Mn} = 1/2$ and sintered in the atmosphere of 800°C for 20 hours, whereby LiMn_2O_4 was produced as the positive electrode active material. The positive electrode material 1a was then obtained by mixing, by weight, 92% LiMn_2O_4 , 3% acetylene black serving as conducting agent, and 5% polyvinylidene fluoride as binder. In order to knead the

positive electrode material 1a into the form of a paste, the poly vinylidene fluoride serving as the binder was employed in the form of N-methylpyrrolidone dispersion. The mixing ratios given above are ratios in terms of the solid fractions.

5 Both faces of the positive electrode current collector 1b made of 20 μm thick aluminum foil were coated with this positive electrode material paste such that positive electrode material layers were formed except a region of width 10 mm on one side edge, which was left uncoated. The
10 film thickness of both positive electrode material layers was the same and the sum of the two film thicknesses after coating and drying was 280 μm , giving a positive electrode plate thickness of 300 μm . After this, the positive electrode plate 1 was compressed using a press roll of
15 diameter 300 mm, to reduce the thickness of the positive electrode plate 1 to 200 μm . The density of the positive electrode material was then 3.0 g/cm^3 .

For the negative electrode material 2a, a mixture of artificial graphite and styrene butadiene rubber (SBR) as a
20 binder in a weight ratio of 97:3 was employed. In order to knead the negative electrode material 2a into the form of a paste, the styrene butadiene rubber binder was employed in the form of an aqueous dispersion. The above mixing ratios are expressed as solid fractions. Both faces of the negative
25 electrode current collector 2b made of 14 μm thick copper foil

were coated with this negative electrode material paste such that negative electrode material layers were formed except a region of width 10 mm on one side edge, which was left uncoated. After this, the negative electrode plate 2 was
5 compressed using a press roll of diameter 300 mm, to reduce the thickness of the negative electrode plate 2 to 170 μm . The density of the negative electrode material was then 1.4 g/cm^3 .

The electrolyte was obtained by dissolving lithium
10 hexafluorophosphate (LiPF_6) as solute in a concentration of 1 mol/dm^3 in a solvent obtained by mixing ethylene carbonate (EC) and diethylene carbonate (DEC) in a volume blending ratio of 1:1.

Corona discharge treatment was performed on the positive
15 electrode material 1a after or before manufacturing the positive electrode plate 1. In performing corona discharge treatment, as shown in Figure 4, the positive electrode plate 1 is arranged on an earthed electrode plate 11 and an electrode 13 of a high-voltage probe 12 is positioned with a
20 separation of about 1 to 2 mm thereabove. Corona discharge treatment is performed by moving the positive electrode plate 1 at a speed of about 1 m/min while generating corona discharge by applying voltage of 6000 V to 10000 V, preferably about 8000 V to the high-voltage probe 12, by a
25 high-voltage power source 14. In this way, polar groups are

produced over the entire surface of the positive electrode material 1a, thereby improving wetting property of the positive electrode material 1a towards the electrolyte.

In a nonaqueous electrolyte rechargeable battery
5 manufactured as above, the affinity between the positive electrode material 1a of the positive electrode plate 1 and the electrolyte is increased by the corona discharge treatment, enabling the lithium ions to easily reach the surface of the positive electrode material 1a, thereby
10 improving charging/discharging characteristic. If corona discharge treatment is also performed on the negative electrode plate 2 or the separator 3, an improvement in charging/discharging characteristic is obtained as well, due to improved wetting property towards the electrolyte, but the
15 improvement in charging/discharging characteristic achieved by performing corona discharge treatment on the positive electrode 1 is remarkable. This is because that, the lithium ions 10 are remarkably facilitated to reach the surface of the positive electrode material 1a by performing the corona
20 discharge treatment since in general, as shown in Figure 3, the lithium ions 10 have difficulty in reaching the entire surface of the positive electrode material 1a because the particles thereof are smaller than those of the negative electrode material 2a in layer form. Corona discharge
25 treatment is more effective for a battery in which the

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packing density of the positive electrode material 1a is increased in order to increase the battery capacity per unit volume, since wetting property of the positive electrode material 1a towards the electrolyte would otherwise be lowered.

The required time for pouring in the electrolyte is considerably shortened due to the improvement in wetting property of the positive electrode material 1a, whose particles are smaller than those of the negative electrode material 2a in layer form. The productivity of batteries is thus considerably increased.

If corona discharge treatment is also performed on the negative electrode material 2a or on the manufactured negative electrode plate 2, or on the separator 3, their wetting property towards the electrolyte is improved, thereby improving wetting property of the rechargeable battery as a whole. The productivity of batteries is further increased due to shortening of the pouring time of the electrolyte.

Thereafter Examples of the present invention and Comparative Examples will be described. A battery for use in Examples and Comparative Examples is a cylindrical rechargeable battery of AAA-size, providing a battery capacity of 600 mAh. In Examples of the invention, corona discharge treatment is performed on the positive electrode plate 1 at voltage of 8000 V and with a speed of 1 m/min, and

in Comparative Examples, corona discharge treatment is not performed.

Example 1	Corona discharge treatment is performed on the positive electrode plate 1 after manufacture
Example 2	Corona discharge treatment is performed on the positive electrode material 1a
Example 3	Corona discharge treatment is performed on the positive electrode plate 1, the negative electrode plate 2, and the separator 3
Comparative example 1	No corona discharge treatment is performed
Comparative example 2	Corona discharge treatment is performed on the negative electrode plate 2
Comparative example 3	Corona discharge treatment is performed on the separator 3

- 5 The pouring time of the electrolyte in the manufacturing process and the discharge capacity at 1 C were measured for each of the above batteries. The values are shown below in reference to values of the comparative example 1, the values being shown as 100.

	Pouring time	Discharge capacity
Example 1	50	120
Example 2	50	120
Example 3	30	125
Comparative example 1	100	100
Comparative example 2	65	103
Comparative example 3	60	105

As is clear from the results, performing corona discharge treatment on the positive electrode plate 1 or its positive electrode material 1a halved the pouring time of the electrolyte and increased the discharge capacity by 20% compared with the case where this was not performed.

In the above embodiment, the examples are illustrated employing a comparatively small rechargeable battery such as a rechargeable battery of AAA size, providing a battery capacity of 600 mAh, it is also suitable to apply the present invention to a large rechargeable battery providing a battery capacity of 100 Ah, as shown in Figure 5.

In Figure 5, numeral 21 represents a positive electrode plate, and numeral 22 represents a negative electrode plate; these are overlaid with a separator 23 made of microporous polyethylene film interposed between them, and are wound in a spiral fashion around a cylindrical core 24 made of aluminum pipe. They are accommodated in an outer tube 25 made of

stainless steel pipe together with an electrolyte. A cylindrical case 27 is constituted by sealing both ends of the outer tube 25 by laser welding of sealing plates 26 made of stainless steel. An electrode pillar 28 constituting a positive electrode terminal or a negative electrode terminal is mounted by penetrating through the middle of the sealing plates 26, 26, through a respective insulator 29. Numeral 30 represents a metal washer arranged on the outside face of the insulator 29 and numeral 31 represents a clamping ring whereby the electrode pillar 28 is fixed to the sealing plate 26. Both ends of the cylindrical core 24 are supported by the cylindrical case 27 through the electrode pillar 28 by fitting and fixing into a recess 28a formed on the inside end of the electrode pillar 28 in the axial direction through a insulating cap 32.

Leads 33 extend from a side edge of the positive electrode plate 21 and the other side edge of the negative electrode plate 22, at intervals. These leads 33 are arranged so as to be positioned at two locations in the radial direction in a condition in which the positive electrode plate 21 and the negative electrode plate 22 are wound around the cylindrical core 24. These leads 33 are ultrasonically joined to a lead joining surface 35 formed at the outer circumference of a connecting shaft 34 of the electrode pillar 28 within the cylindrical case 27, respectively.

In the rechargeable battery of this embodiment, the same benefits are obtained by performing corona discharge treatment of at least the positive electrode plate 21 in the same way as in the embodiment described above. If corona discharge treatment is performed on all of the positive electrode plate 21, the negative electrode plate 22 and the separator 23, the pouring time of the electrolyte is reduced to 24 hours, compared with 72 hours required if corona discharge treatment is not performed. Although hereinabove all the embodiments described related to a cylindrical nonaqueous electrolyte rechargeable battery, the same beneficial effect is also obtained for a battery having a shape other than cylindrical.

INDUSTRIAL APPLICABILITY

According to the present invention, the nonaqueous electrolyte rechargeable battery achieves excellent charging/discharging characteristic, since performing of corona discharge treatment on the positive electrode material or the manufactured positive electrode plate increases affinity between the positive electrode material of the positive electrode plate and the electrolyte, facilitates the lithium ions to move uniformly. Corona discharge treatment is more beneficial in a battery in which the packing density of the positive electrode material is raised in order to achieve

higher battery capacity per unit volume. The invention is
useful in producing rechargeable batteries of excellent
charging/discharging characteristic with high productivity,
since the pouring time of the electrolyte is considerably
5 shortened due to the improved wetting property of the
positive electrode material towards the electrolyte.

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CLAIMS

1. A nonaqueous electrolyte rechargeable battery comprising:

5 an electrode group including a positive electrode plate (1, 21) including a positive electrode material (1a), a negative electrode plate (2, 22), the positive and negative electrode plates being superimposed with a separator (3, 23) interposed therebetween;

10 an electrolyte; and

a battery case (4, 27) for accommodating the electrode group and the electrolyte; wherein:

corona discharge treatment is performed on one of the positive electrode material (1a) and the positive electrode
15 plate (1, 21).

2. The nonaqueous electrolyte rechargeable battery according to claim 1, wherein corona discharge treatment is performed on one of the negative electrode material (2a) and
20 the negative electrode plate (2, 22).

3. The nonaqueous electrolyte rechargeable battery according to one of claims 1 and 2, wherein corona discharge treatment is performed on the separator (3, 23).

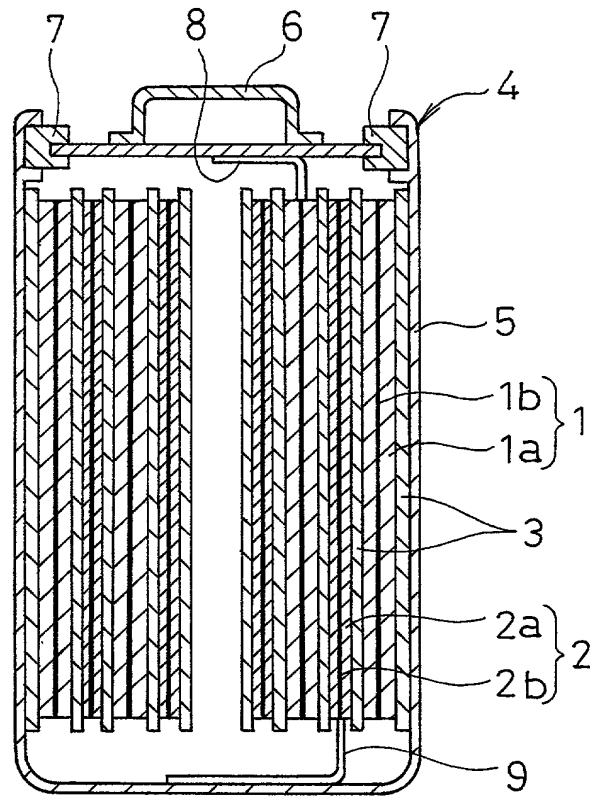
Fig. 1

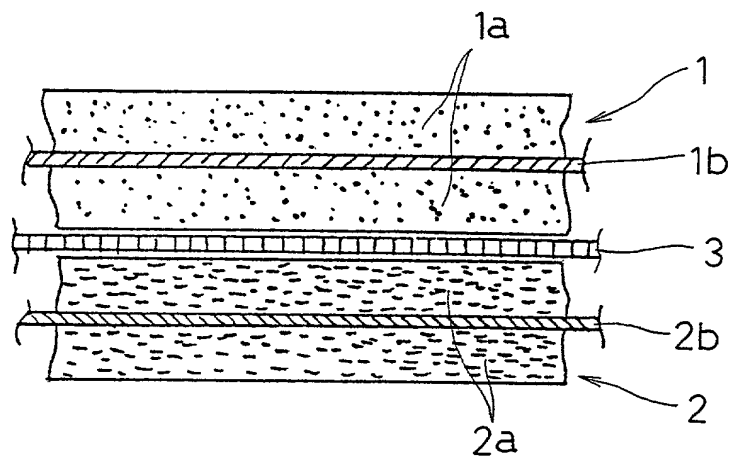
Fig. 2

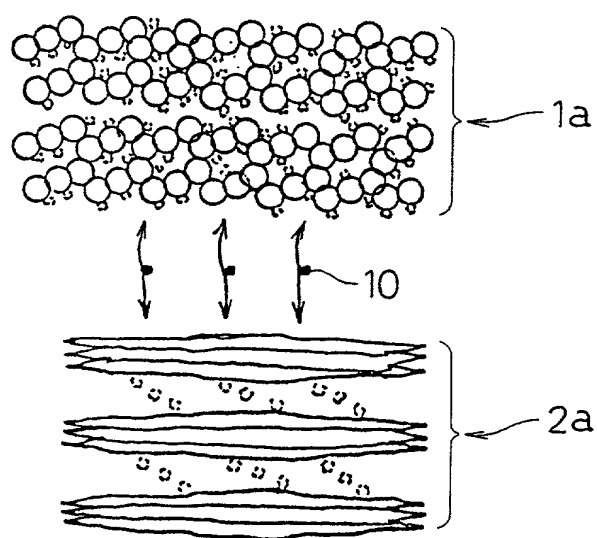
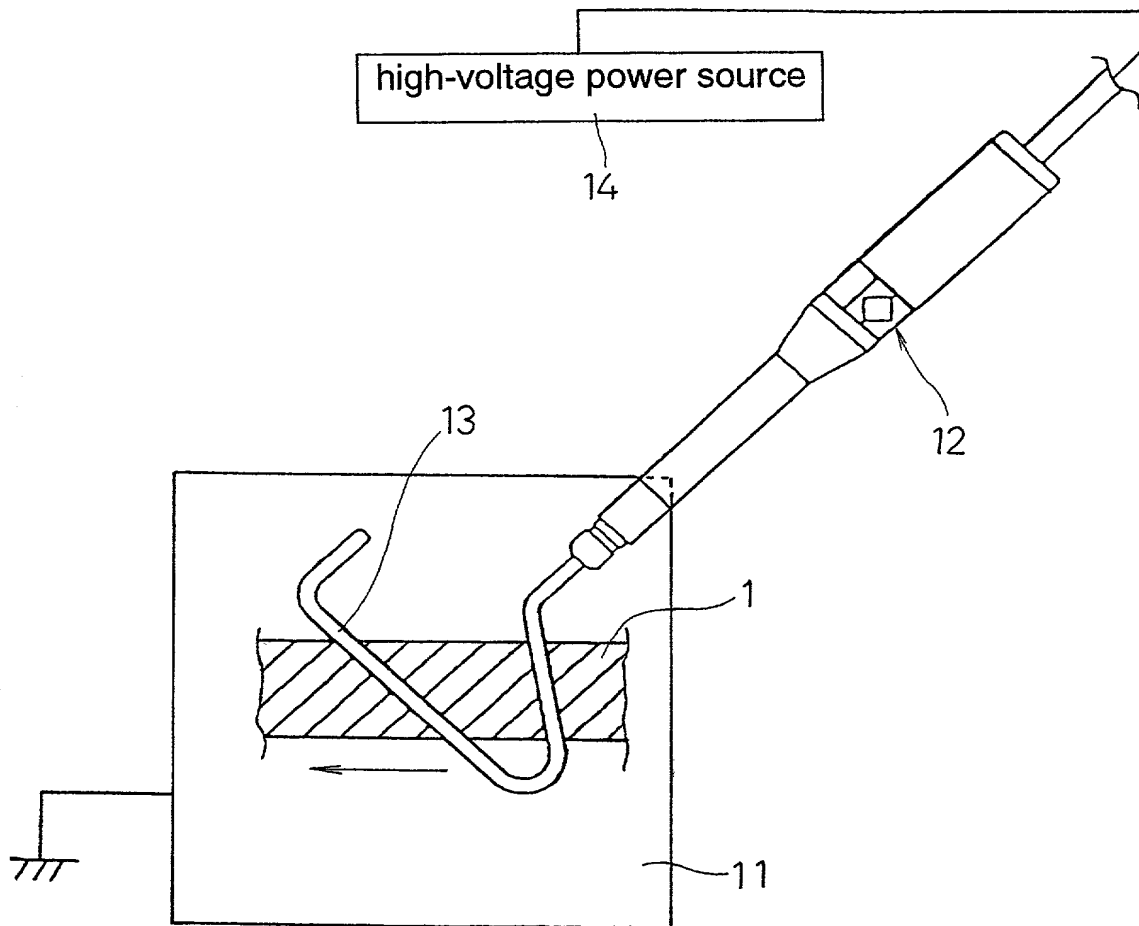
Fig. 3

Fig. 4

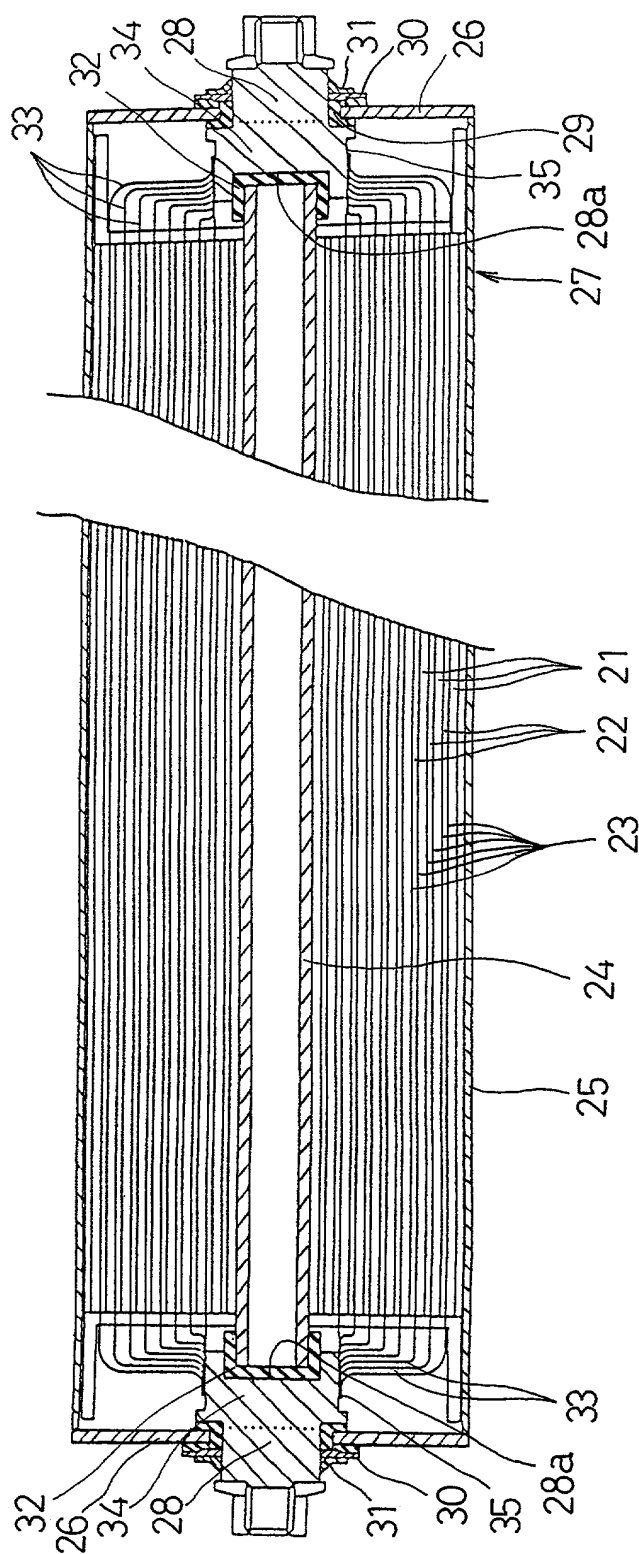


Fig. 5

Declaration and Power of Attorney For Utility or Design Patent Application

特許出願宣言書

Japanese Language Declaration

私は、下欄に氏名を記載した発明者として、以下のとおり宣言する：

私の住所、郵便の宛先および国籍は、下欄に氏名に続いて記載したとおりであり、

名称の発明に関し、請求の範囲に記載した特許を求める主題の本来の、最初にして唯一の発明者である（一人の氏名のみが下欄に記載されている場合）か、もしくは本来の、最初にして共同の発明者である（複数の氏名が下欄に記載されている場合）と信じ、

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

NONAQUEOUS ELECTROLYTE

RECHARGEABLE BATTERY

the specification of which is attached hereto unless the following box is checked:

☒ was filed on April 7, 2000 as

United States Application Number _____

and was amended on _____ (if applicable) or,

PCT International Application Number PCT/JP00/02303

and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority under Title 35, United States Code §119(a-d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States, listed below. I have also identified below, by checking the "No" box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed:

上記発明の明細書（下記の欄でX印がついていない場合は、本書に添付）は、

_____年_____月_____日に提出され、

米国出願番号 _____ とし、

（該当する場合）_____年_____月_____日に訂正されました。又は、

特許協定条約国際出願番号 _____ とし、

（該当する場合）_____年_____月_____日に訂正されました。

私は、前記のとおり補正した請求の範囲を含む前記明細書の内容を検討し、理解したことを陳述する。

私は、連邦規則法典第37編第1条第56項に定義されるとおり、特許資格の有無について重要な情報を開示すべき義務があることを認めます。

私は合衆国法典第35部第119条(a-d)項又は第365条(b)項に基づく、下記の外国特許出願又は発明者証出願、或いは第365条(a)項に基づく、少なくとも米国以外の1ヶ国を指名したPCT国際出願の外国優先権を主張し、更に優先権の主張に係わる基礎出願の出願日前の出願日を有する外国特許出願、又は発明者証出願或いはPCT国際出願を以下に“なし”の箱に印をつけることにより明記する：

Prior foreign applications
先の外国出願

11-100749

Japan

08/04/1999

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願の年月日)

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願の年月日)

☐ その他の外国特許出願番号は別紙の追補優先権欄にて記載する。

☐ Additional foreign application numbers are listed on a supplemental priority sheet attached hereto.

Priority claimed

優先権の主張

☒ ☐

Yes No

あり なし

☐ ☐

Yes No

あり なし

Japanese Language Utility or Design Patent Application Declaration

私は、合衆国法典第35部第119条(e)項に基づく、下記の合衆国仮特許出願の利益を主張する。

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below.

(Application No.)
(出願番号)

(Day/Month/Year Filed)
出願の年月日

(Application No.)
(出願番号)

(Day/Month/Year Filed)
出願の年月日

(Application No.)
(出願番号)

(Day/Month/Year Filed)
出願の年月日

☐ その他の合衆国仮特許出願番号は別紙の追補優先権欄にて記載する。

☐ Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

私は、合衆国法典第35部第120条に基づく下記の合衆国特許出願、又は第365条(c)項に基づく合衆国を指名したPCT国際出願の利益を主張し、本願の請求の範囲各項に記載の主題が合衆国法典第35部第112条第1項規定の様式で、先の合衆国特許出願又はPCT国際出願に開示されていない限度において、先の出願の出願日と本願の国内出願日又はPCT国際出願日の間に有効となった連邦規則法典第37部第1章第56条に記載の特許要件に必要の情報を開示すべき義務を有することを認める。

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application No.)
(出願番号)

(Day/Month/Year Filed)
(出願の年月日)

(現況)
(特許済み、係属中 放棄済み)

(Status)
(patented, pending, abandoned)

(Application No.)
(出願番号)

(Day/Month/Year Filed)
(出願の年月日)

(現況)
(特許済み、係属中 放棄済み)

(Status)
(patented, pending, abandoned)

☐ その他の合衆国又は国際特許出願番号は別紙の追補優先権欄にて記載する。

☐ Additional U.S. or international application numbers are listed on a supplemental priority sheet attached hereto.

私は、ここに自己の知識にもとずいて行った陳述がすべて真実であり、自己の有する情報および信ずるところに従って行った陳述が真実であると信じ、さらに故意に虚偽の陳述等を行った場合、合衆国法典第18部第1001条により、罰金もしくは禁錮に処せられるか、またはこれらの刑が併科され、またかかる故意による虚偽による陳述が本願ないし本願に対して付与される特許の有効性を損なうことがあることを認識して、以上の陳述を行ったことを宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

私、下記署名者は、ここに記載の米国弁護士または代理人に本出願に関し特許商標庁にて取られるいかなる行為に関して、同米国弁護士又は代理人が、私に直接連絡なしに私の外国弁護士或いは法人代表者からの指示を受け取り、それに従うようここに委任する。この指示を出す者が変更の場合には、ここに記載の米国弁護士又は代理人にその旨通知される。

The undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from either his foreign patent agent or corporate representative, if any, as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

Japanese Language Utility or Design Patent Application Declaration

委任状： 私は、下記発明者として、下記に明記された顧客番号を伴う以下の弁護士又は、代理人をここに選任し、本順の手続きを遂行すること並びにこれに関する一切の行為を特許商標庁に対して行うことを委任する。そして全ての通信はこの顧客番号宛に発送される。

顧客番号 7055

現在選任された弁護士は下記の通りである。

4

Neil F. Greenblum
Bruce H. Bernstein
James L. Rowland
Arnold Turk

POWER OF ATTORNEY: As a named inventor, I hereby appoint the attorney(s) and/or agent(s) associated with the Customer Number provided below to prosecute this application and transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to that Customer Number:

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発明者の署名	Inventor's signature	<u>Kenji Kimura</u> Date <u>July 11, 2001</u>
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第2の共同発明者の氏名 (該当する場合)	Full name of second joint inventor, if any	<u>Keisuke Omori</u> 2W
同第2共同発明者の署名	Second Inventor's signature	<u>Keisuke Omori</u> Date <u>July 11, 2001</u>
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(第六またはそれ以降の共同発明者に対しても同様な情報および署名を提供すること。)

(Supply similar information and signature for third and subsequent joint inventors.)

Japanese Language Utility or Design Patent Application Declaration

第三の共同発明者の氏名		Full name of third inventor, if any <u>Seiichi Uemoto</u> <i>30</i>	
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第四の共同発明者の氏名		Full name of fourth inventor, if any	
共同発明者の署名	日付	Fourth Inventor's signature	Date
住所		Residence	
国籍		Citizenship	
郵便の宛先		Post Office Address	
第五の共同発明者の氏名		Full name of fifth inventor, if any	
共同発明者の署名	日付	Fifth Inventor's signature	Date
住所		Residence	
国籍		Citizenship	
郵便の宛先		Post Office Address	
第六の共同発明者の氏名		Full name of sixth inventor, if any	
共同発明者の署名	日付	Sixth Inventor's signature	Date
住所		Residence	
国籍		Citizenship	
郵便の宛先		Post Office Address	

(それ以降の共同発明者にたいしても同様な情報および署名を提供すること。)

(Supply similar information and signature for subsequent joint inventors.)